Stable Isotopes in Atmospheric Gases: the INSTAAR NOAA Collaboration

- CO₂: $\delta^{13}$C and $\delta^{18}$O
- CH₄: $\delta^{13}$C and $\delta$$D$
- CO: $\delta^{13}$C

This talk: $\delta^{18}$O (and advertisement for $\delta^{13}$C of CO₂)... Colin Allison and Roger Francey

Bruce Vaughn: $\delta^{13}$C and $\delta$$D$ of CH₄, ICPs and calibrations
New Approaches to $\delta^{13}$C of CO$_2$

- $\delta^{13}$C has proven useful in separating land and ocean carbon fluxes on large scales
- Gold left to be mined
- As independent flux estimates of ocean and land improve, and as regional networks become more dense (e.g. North America)...
- Use $\delta^{13}$C to focus in on
  - Disequilibrium: balance between photosynthesis and respiration
  - Fractionation during photosynthesis: water use and carbon

Caroline Alden: PhD Thesis (see her talk next week!)
\[ \delta^{18}O \text{ of } CO_2 \]

Candice Evans: MS Thesis and article in preparation
Why $\delta^{18}O$ of CO$_2$?

Controlled by:
• Photosynthesis (leaf water exchange)
• Respiration (soil water exchange)
• Climate (spatial distribution of $\delta^{18}O$ of water)

From Yakir and Sternberg, 2000
The problem: Some air samples collected without drying...

$\text{CO}_2$ and $\text{H}_2\text{O}$ can exchange oxygen in flask: Gemery et al, 1996, JGR
The signal...
The noise…

$\text{CO}_2$ exchange with $\text{H}_2\text{O}$ causes abnormally light values

Past strategy has been to warn users away from all data 30N to 30S… but can we do better than this?
Recap from 2007: Pair rejection Problem

P: sampled “wet”

D and G are both sampled “dry”
Not just a pair rejection problem... problem data survives data QA/QC controls
Drier sites seem to not have this problem… Station M in Norwegian Sea
Some sites look good in the winter, but not the summer... seasonal humidity changes
Is there a lower limit of humidity below which we are safe?
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![Graph showing linear regression of seasonal average specific humidity vs. % rejected δ¹⁸O-CO₂.](chart.jpg)
Problems do appear to start in earnest when SH > 10 to 12 g/kg
And below 10 g/kg, all generally looks ok…
Mostly Wet sites

Database error by bootstrapping
Generally Dry Sites
The long time record
Does insolation pace $\delta^{18}$O of CO$_2$?

Recent papers postulate a link:
- More sun
- More evap in tropics
- More humidity
- More ppt

A decadal solar effect in the tropics in July–August, van Loon Meehl and Arblaster, 2004

A Lagged Warm Event–Like Response to Peaks in Solar Forcing in the Pacific Region, Meehl and Arblaster, 2009
Where next?

• New data release with flags for different filters

• New filtering strategy:
  – Normal filters (pair, etc.)
  – Specific humidity filter… metrological data needed for all flasks, included as in data release
The rug plot: All data that passes normal quality controls

Apply SH filters (8, 10 and 12 g/kg): Examine Impact on database
Impact on database: Existing database minus 12 g/kg filter
Impact on database: 8 g/kg filter